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OF THE

Elisha Mitchell Scientific Society

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PROCEEDINGS OF THE FIFTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE HELD AT RALEIGH, N. C., MAY 18 & 19, 1906.

FRIDAY, MAY 18TH, 1906.

This evening was devoted to a joint meeting of the Academy and Chemical Society in the Auditorium in the Agricultural Building at which the Presidential address upon the subject: "The Source of the Sun's Heat" was delivered by Prof. John F. Lanneau of Wake Forest College. The address was followed by a smoker.

SATURDAY, MAY 19TH, 1906.

A meeting of the Exucutive committee was held. The following members were present: President John F. Lanneau, Secretary F. L. Stevens, and Professor Collier Cobb.

The following members were nomitated to the Academy by the Executive Committee: Mr. J. C. Temple, of the A. & M. College, Mr. F. C. Reimer, of the A. & M. College, Dr. E. W. Gudger, of Greensboro, Dr. Archibald Henderson, of Chapel Hill, and Mr. R. S. Woglum, of Raleigh.

Printed December 8, 1906.

A business meeting of the Academy of Science followed. The minutes of the last meeting were read and approved. The two following amendments previously submitted to the Executive Committee were received and adopted by the Academy:

1. To strike out of Article 2, Section 1, all of the second paragraph.

2. To strike out from Article 2, Section 2, the following words: "Three dollars and for associates."

The names of the following persons previously accepted by the Executive Committee were received and the candidates elected to membership in the Academy: J. C. Temple, F. C. Reimer, E. W. Gudger, Archibald Henderson, and R. S. Woglum. A nominating committee previously appointed reported the nominations as follows: For President, Professor Collier Cobb; Vice-president, Professor J. L. Lake; Secretary-Treasurer, F. L. Stevens; members of the Executive Committee in addition to the ex-officio officers, Dr. W. C. Coker, Franklin Sherman, and Professor J. F. Lanneau. The report of the Committee was adopted and members named declared elected to the respective offices.

The report of the treasurer showing the balance of $141.43 was received. Mr. C. B. Williams was appointed as auditor.

Following the business meeting was held the meeting for the presentation of papers, a summary of which follows:

Autophytographs, ... Collier Cobb

Name suggested by C. H. White (Am. Jour. Sci., March, 1905) for a plant record formed by the extraction of coloring matter through decay of plant, or a black deposit reproducing perfectly the leaves of the plants, illustrated by specimens from the neighborhood of Wilkesboro, N. C., and elsewhere. Such records have also been made in geological past, and Professor Cobb reported fern autophytographs on carboniferous rocks from near Pottsville, Pa., exhibiting two different specimens of the same.

Notes on the Variation in the Number of Eggs or Young Produced by Some American Snakes . . C. S. Brimley

This paper gave the largest, smallest, and average number of eggs or young produced, according to the author's experience by the following species of American snakes: Eutoenia sirtalis, Eutoenia saurita, Natrix sipedon, Haldea striatula, Storeria dekayi, Storeria occipitomaculate, Virginia valerioe, Bascanium constrictor, Heterodon Platyrhinus, Ophibolus getulus, Cyclophis aestivus, Coluber quadrivittatus, Carphophiops Amoenus, Ancistrodon contortrix, Ancistrodon piscivorus. Comments are also made on the confusion caused by the application locally of the same popular or local name to different species of snakes in different places, and by different names being applied to the same species.

The Embryo-sac of Liriodendron . . . . . W. C. Coker

The development and structure of the embryo-sac of the ordinary tulip tree, Liriodendron, was explained with blackboard drawings. The special point of interest was that though this tree is ancient geologically, yet its embryo-sac presents no unusual features.

Sugaring for Moths . . . . . C. S. Brimley

The author's experience in sugaring for moths in July, August, and September, was given. Names of the mixtures employed and how applied, and what species of moths and other insects were captured. Notes that a very large proportion of the attracted moths were species of economic importance, viz., the army-worm and cutworm moths, which do considerable injury to field and garden crops. Notes what insects were attracted to the sugared patches in the day time and also that rough barked trees were better to sugar than smooth-barked ones.

Rhoetic Flora of Moncure Shales . . . . . Collier Cobb

Specimens of Liriodendron (?) reported from Deep River Trias in 1904 in association with Macrotoeniopteris, and then regarded by speaker as Lower Trias, led to the tracing of this bed eight miles northeastward through Lockville to Moncure, and to the discovery of one nearly complete Liriodendron leaf and several fragments in association with lycopods, conifers, and equisetaceae with many examples of more modern plants yet to be determined, constituting what is probably a transition flora. Many of the specimens were from a well recently dug by the Seaboard Air Line Railway.

The Influence of Citrous Stocks on Scions Mr. F. C. Reimer

An investigation was made in Florida to determine whether the stock influences the scion in any way. The following outline covers most of the work which was done:

1. Influence on rate of growth—(a) in diameter, (b) in height.
2. On shape of tree.
3. On hardness.
4. On diseases.
5. On fruit—(a) amount, (b) quality, (c) season of ripening, (d) color, (e) dropping.

Interesting results were obtained which will appear in *Science* in full at a later date.

Mr. J. C. Temple discussed the bacterial flora of cow manure, showing the average number of germs present in fresh manure and in manure of different ages. The relation of these various germs to the nitrogenous material of the manure. He also presented important results concerning the distribution abundance and variation of the colon bacillus.

A paper by Lewis T. Winston in his absence was read by Dr. F. L. Stevens on "Bacterial Analysis of Various Lithia

Waters," in which it was stated that while most of the lithia waters were above reproach from a bacterial view point, some of them are of such condition that if submitted to the ordinary board of health analysis they would be condemned.

Liverwort Types for Elementary Classes . . W. C. Coker

It was suggested that Pallavicinia, on account of its simple structure and easily demonstrated organs was far more suitable for elementary work than the more complex Marchantia which is generally used. Frullania Virginica was suggested as the best type for use in demonstrating the development of the capsule.

Mr. W. C. Etheridge explained a series of tests which he had made concerning the various methods of analysis of milk to determine the effect of the various media, various ages of plate, different degrees of acidity, and effect of ventilation upon the bacterial count.

Mr. C. S. Brimley presented a paper on the "Zoology of Lake Ellis, Craven County, N. C."

The Endosperm of the Pontederiaceae . . . . W. C. Coker

It was shown that the endosperm of the three genera of this family so far investigated was of two sorts. The definitive endosperm nucleus on its first division forms a wall separating the sac into an upper and a lower part. The endosperm in the upper part is quite different in appearance from that in the lower.

Food Adulteration . . . . . Mr. W. M. Allen

This paper showed the great effect of the adulteration of human foods on mankind; how it affects both the health and the wealth.

It seems that the greatest danger to health lies in the use

of chemical preservatives in fresh meats and sausages by butchers and meat men, often ignorant, having no conception of what they are dispensing to their customers.

The meeting was well attended and interest was manifest.

Following the meeting for the presentation of papers the Academy of Science and the Chemical Section adjourned to Giersch's café where the visiting members were entertained at lunch by the Raleigh members of these two organizations.

F. L. STEVENS,
SEC. & TREAS.

THE BUILDING AND ORNAMENTAL STONES OF NORTH CAROLINA, A REVIEW.

BY JOSEPH HYDE PRATT, STATE GEOLOGIST.

There has recently been published by the North Carolina Geological and Economic Survey a report on the Building and Ornamental Stones of the State, which was prepared by Prof. Thomas L. Watson and Francis B. Laney, with the collaboration of Dr. George P. Merrill. This report represents nearly three years of field and laboratory work and shows that North Carolina is well supplied with a great variety of building stone materials, particularly those of a granitic type. With perhaps the possible exception of Georgia, it is better supplied with both as regards quality and variety than any of the other Appalachian States south of New England. When this fact is taken in connection with the mildness of the climate, which permits a long season of outdoor labor, and with the cheapness of labor itself, it will undoubtedly result in the development of a very extensive industry.

The granitic rocks have been especially studied by Dr. Watson, who worked almost exclusively in the granites and gneisses, with incidental reference to the associated eruptions, the diorites, diabases, and gabbros. In connection with the field work on these granitic rocks, he was ably assisted by Mr. Laney, who, however, devoted the larger part of his time to the marbles, limestones, sandstones, serpentines, and road materials,

Dr. Merrill's guiding hand is plainly seen in the character of the work and its form of presentation. There were but few tests made to ascertain resistance to crushing, shearing,

elasticity, or absorption, chiefly because the report does not pretend to be either exhaustive or final, but has been published to call attention to the deposits of stone, especially those of known economic importance, and to indicate how these can be opened and operated profitably. No chemical analyses were attempted, nor were they for the most part considered essential for the present work, as Dr. Merrill still adheres to his opinion that more can be learned from an examination in the field than through all known laboratory tests taken together. There are a number of chemical analyses given throughout the report which have been taken, however, from previous reports of the Survey.

The volume is divided into nine chapters, with a short appendix on stones for road buiding. In Chapter I, which is entitled Preliminary Generalities, the essential qualities of building stones are thoroughly discussed, attention being called to the influence that color has on the market value of a stone; the ease or difficulty with which a stone can be worked, and the location of the deposit with respect to transportation facilities. The surface features of the State are considered and it is shown that the geological formations which are capable of yielding desirable stone for structural purposes or ornamentation traverse the State in northeast and southwest directions. Beginning at the western margin of the coastal plain, there is found extending northeast from Raleigh a broad belt of gneissic rocks, succeeded on the west by one of brown sandstone, and this in order by belts of schist, granites, and gneisses to the State line, the last mentioned belt carrying in Cherokee, Graham, and Swain counties a narrow belt of marble. Within these areas there are numerous minor exceptions to the regular order mentioned above. The geographic position of the State is considered with reference to other than local markets and it is clearly shown that North Carolina is near the center of an area containing hundreds of large and prosperous cities and towns which will afford a market for a much larger amount

of building stones than it is now supplying, which should result in the development of the quarry industry on a much larger scale and without any danger whatever of ruinous competition.

Chapters II, IV, and VI take up in detail the building and decorative stones roughly classified as follows: (1) The crystalline siliceous rocks, including the granites, gneisses, and diabases, or traprocks; (2) the calcareous rocks, including all limestones and dolomites, both the crystalline and compact common varieties; and (3) the fragmental or clastic rocks, including the sandstone and clay slates. Those of the first group result either as erupted molten matter from the earth's interior or from the metamorphism of siliceous sediments. Those of the second group originate mainly as deposits of calcareous mud from the breaking up of shells, corals, and the remains of other marine animals on an old sea bottom. Those of the third group result from the breaking up of older rocks, and the accumulation on the bottom of lakes and seas of the resultant sand, clay, or mud in beds of varying thickness, to be subsequently hardened into stone.

"Now the essential difference between a marble and a compact common limestone, like those of Ohio or Kansas, is that the first has undergone, through the combinded action of heat and pressure, just the right degree of change, or metamorphism as it is technically called, to develop in it crystallization and color; the essential difference between a brick or fire clay and a cleavable slate suitable for roofing, is, as explained elsewhere, that the first named still retains its plastic condition as it was laid down in the form of fine silt on a sea bottom, while the slate has by geological agencies, by actual movements of the earth's crust, been so squeezed and compressed as to lose all resemblance to its former self, and become the cleavable article of commerce we now find it.

"These processes of change, as noted above, are dependent very largely upon the actual movements; warpings and foldings as one might say, of the earth's crust and the heat and

chemical action which is thereby generated, and since these movements take place only with extreme slowness, whole geologic ages being occupied in their inception and completion, it follows as a matter of course that these metamorphic rocks, these gneisses, marbles and roofing slates, are found only among the older rocks and only in those portions of the country where this crust has been warped, compressed, and folded as in the process of mountain making."

Thus, one will find these rocks in their best development in those regions bordering along more or less extensive mountain ranges.

The area of the State containing rocks of the first class is very extensive and includes the three larger physiographic provinces of the State, namely, the coastal plain, the Piedmont plateau, and the Appalachian Mountain; but the greater part of the granites and other crystalline rocks of economic importance are included in the Piedmont plateau region. Along the inner margin of the coastal plain region there are a number of small workable areas of granite of excellent quality; but in the mountain region the large granitic areas are usually schistose in structure and are not very desirable for the higher grades of work in which granites are used. These crystalline rocks are discussed in groups:

I. The Coastal Plain Area, this area including Wilson, Edgecombe, Nash, Anson, and Richmond counties. In this region the areas capable of producing workable granite either lie close to or are crossed by the principal lines of railroad in the eastern part of North Carolina, rendering them easily accessible and providing ample facilities for transportation of the stone. The outcrops are usually large and are so located as to offer advantageous quarry sites. They are all biotite granites, showing a considerable range of variation in color and texture, from light gray to pink with occasionaly a mixed yellowish and pink appearance. No systematic quarrying has as yet been undertaken and all that has been quarried has been used locally.

II. The Piedmont Plateau Region.

1. The Northeastern Carolina Granite Belt, including Wake, Franklin, Vance, Granville, and Warren counties. In this belt extensive workable areas of different grades of granite are found suited for all grades of work in which granite is used, except for the better grades of monumental work. Systematic quarrying, however, has been limited to areas in and around Raleigh, Wake county and at and near Greystone and Middleburgh, Vance county. These quarries have been operated quite extensively, furnishing stone to Eastern Virginia and Carolina, principally in the form of blocks and curbing for street purposes; and for general building purposes. Throughout this belt the granites show but little variation in mineral composition and, with one exception, they are biotite-granites. Minerals such as free sulphides and iron oxides, which are a source of discoloration to stone on exposure, are practically absent from the granites of this belt.

2. The Carolina Metamorphic Slate and Volcano Belt, including Orange, Durham, and Chatham counties. The country rocks of this belt comprise argillaceous, sericitic and chloritic metamorphosed slates and crystalline schists; sedimentary pre-Juratrias slates; and ancient volcanic rhyolites, quartz porphyries, and pyro-clastic breccias that are often sheared and altered andesites. Rocks of granitic composition have as yet only been noted in Orange county, and they are of doubtful commercial value except for railroad ballast and road purposes.

3. The Carolina Igneous Belt (The Main Granite Belt), including Mecklenburg, Gaston, Cabarrus, Iredell, Rowan, Davidson, Davie, Forsyth, Guilford, and Alamance counties. In this belt granite is one of the principal and most widespread rocks, and in each of the ten counties included in the belt, extensive areas of granite are exposed. Outcrops of firm and hard moderately fresh granite are not uncommon, and as a rule the exposures are large enough to admit of the

opening of large quarries without much stripping. The stone is usually well suited to the many purposes for which granite is used, and the belt is traversed in nearly all directions by lines of railroads which offer ample facilities for transportation. Notwithstanding these conditions, only a limited amount of quarrying has been done in these counties,

Figure 1. Boulder outcrop of orbicular-gabbro diorite, Hairston farm, Davie county, 10 miles west of Lexington, Davidson county.

with the exception of Rowan, where systematic quarrying has been developed on a large scale on the Dunns Mountain granite ridge.

There are two distinct phases of the granite developed, an even granular or normal and a porphyritic granite, both of which have wide distribution within the limits of the belt and, with one exception, represent different phases of the

same rock mass, the porphyritic texture grading into the even-granular. With hardly an exception the granites are mica (biotite) bearing and they vary in color from nearly white, through the lighter to the darker shades of gray. In several places over Dunns Mountain a beautiful shade of pink granite is quarried. This stone has attracted a great deal of attention and is much admired as a decorative stone.

4. The Western Piedmont Gneiss and Granite Belt, including Surry, Wilkes, Alleghany, Alexander, and Cleveland counties. In this belt the massive granites are less abundantly distributed than over other parts of the granitic areas. They are all biotite-bearing, usually of light color and of medium texture. No injurious minerals are, as a rule, observed. The rocks possess marked strength and durability and are very desirable granites for certain grades of work. Mt. Airy, Surry county, one of the principal localities in this belt yielding rock of this type, constitutes the largest quarrying center in the State. The demand for this stone is rapidly increasing and wherever used has given entire satisfaction both as regards color and durability.

III. The Appalachian Mountain Region, comprising McDowell, Buncombe, Henderson, Madison, Jackson, Haywood, Macon, Transylvania, Swain, Mitchell, Caldwell, Watauga, and Ashe counties.

No systematic quarrying has as yet been undertaken at any point in this mountain region, but numerous small openings have been made in exposures of the rock in many places, but the stone has been used entirely for local purposes. The larger amount of the rock quarried has been used for ballast and road purposes. Transportation is the serious difficulty confronting the quarrying of the mountain granite for building purposes, except for local use.

The report shows that North Carolina is well supplied with granite deposits that are easily accessible and are of a

quality that will permit of their being used for all grades of work.

Some of the rocks included under the head of the crystalline rocks are of especial interest and are mentioned more in detail.

Orbicular Gabbro-Diorite:— The orbicular gabbro-diorite is found on the Hairston plantation, Davie county, ten miles west of Lexington and one mile west of Oak Ferry. It occurs in high boulders occupying a low indistiuct ridge, which culminates in a peak or knoll about thirty feet above the surrounding plain, Fig. 1. This is the only point where the orbicular rock outcrops prominently, but it can be traced in a southwest direction by means of residual decay for a distance of one-half to three-quarters of a mile in length and of several hundred yards in width. The orbicular rock undoubtedly occurs in the form of a typical dike penetrating the porphyritic granite and is parallel to and probably of the same age as some large, massive, unaltered diabase dikes in the vicinity which are intersecting the same rock..

This rock presents two distinct and strongly contrasted phases, one the pronounced orbicular and the other a granitic. Around the knoll referred to, the rock shows the typical orbicular texture, with the well rounded spheres varying in width from one-eighth to one inch and sometimes two inches in diameter. Some distance from the knoll the rock assumes a granitic texture, but is composed of the same minerals. Mineralogically, this rock is composed principally of a basic plagioclase feldspar, showing, as a rule, but slight polysynthetic twinning, uralitic hornblende, and diallage. Besides these, titanite, apatite, magnetite, and zircon occur as accessory minerals, and quartz, muscovite, calcite, and zoisite as secondary minerals.

In color the rock is dark, with a greenish tinge due to the dark green hornblende. It has a pronounced mottled appearance produced by the nearly black green nodules of hornblende in a ground-mass of the intensely white plagioclase feldspar.

The contrast is very pleasing and it is brought out much more prominently in the cut and polished surfaces. The spheres

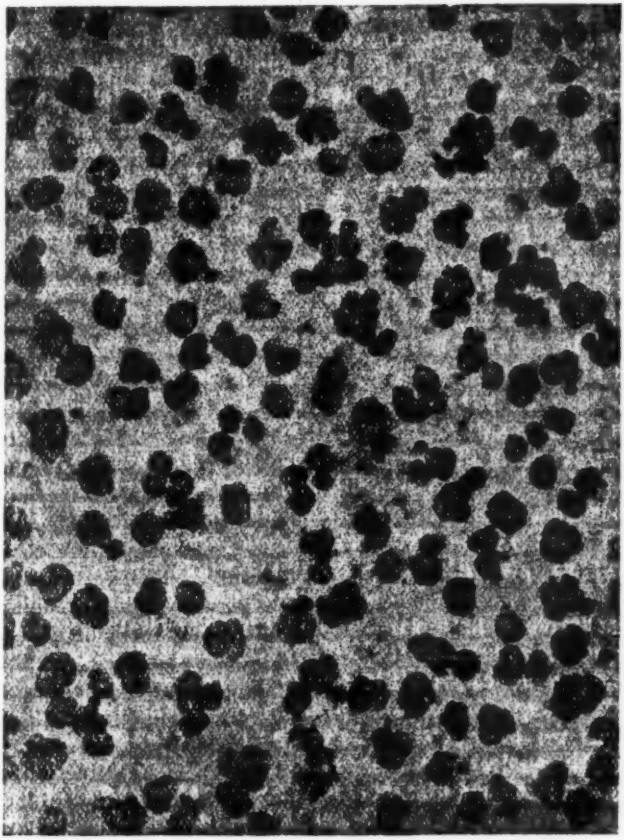

Figure 2. Photograph of fresh surface of leopardite showing the stone when broken at right angles to the long parallel streaks or pencils of a dead black color.

usually exhibit a fibrous, radiating structure from a common center outward. In some instances a small fragment of feldspar, quartz, or pyrite has been the nucleus about which the spheres of the hornblende have been formed. The concentric structure which is usually observed in orbicular rocks is not at all pronounced in the North Carolina rock; and where the spheres of orbicular granite and diorite heretofore described are composed usually of a number of minerals, the North Carolina rock is only composed of one, the dark green hornblende.

As a decorative or ornamental stone, this unique stone should find very great favor. It works easily and well as is shown by a polished column and sphere that are in the State Museum at Raleigh. That it wears well is demonstrated by the fact that some of this stone quarried prior to the Civil War and used for gate posts and steps to the house on the Peter Hairston property, do not show any signs of decay.

Quartz-Porphry (*Leopardite*):— Intersecting the biotite-granite at Belmont Springs 1½ to 1¾ miles east of Charlotte, Mecklenburg county, is a dike of quartz porphry about one-half mile long, whose width nowhere exceeds 25 feet and which has been most appropriately named Leopardite. It is a dense, hard, tough and compact cryptocrystalline rock, which breaks with a conchoidal fracture. The fresh rock is nearly pure white, tinged in places a very faint greenish, and penetrated by long parallel streaks or pencils of a dead black color. If it is broken at right angles to these streaks, the surface is dotted with rounded irregular black spots varying from pin heads up to half an inch in diameter. This peculiar spotted appearance is well illustrated in Fig. 2. When the rock is broken or cut parallel with the direction of the pencils, the surface is streaked with long irregular black lines, which are sometimes approximately parallel and at others assume a dendritic or fern-like appearance, as illustrated in Fig. 3. These black streaks or pencils are not regularly distributed throughout the quartz-porphry, but in

some areas they are entirely absent, while in others they are crowded very closely together.

Mineralogically the rock is composed essentially of feldspar, both potash and plagioclase varieties, with a smaller amount of quartz,, which forms minute irregular interlocking grains. Considerble of it is intergrown with the feldspar in micrographic structure, forming more or less rounded disk-like areas. The black streaks or pencils are composed of oxides of manganese and iron and are supposed to represent the percolation of manganese and iron solutions through the rock.

The rock is susceptible of an excellent polish and could be used with splendid effect in inlaid work. On account, however, of its exceeding hardness and toughness and absence of any definite rift, it will be a rather expensive stone to quarry.

Unakite:— In Madison county, about 5 miles southwest of Hot Springs, there is an irregular area of granite containing epidote as a characterizing mineral. The main mass of this rock is described as a dark pink and green epidote-biotite-granite of coarse texture and somewhat schistose structure varying from a typical schistose granite in which the quartz is present in the usual amount to a nearly quartzless rock of the same color and texture.

Penetrating this granite probably in the form of narrow veins is the unique and beautiful variety of granite known as unakite. This rock is composed of yellow-green epidote, dull pink or red feldspar and quartz. The unakite is not uniform in color and composition, but shows pronounced gradation into a highly feldspathic rock of pink color on the one hand and an epidote rock of a yellow-green color on the other. Usually in the veins the normal unakite, which is a coarse, massive rock of even texture, occupies the middle portion of the vein and graduates toward the enclosing gneiss either into the feldspathic or epidotic rock or both.

Under the microscope the unakite is shown to be composed of the usual granitic minerals such as orthoclase and

microcline in nearly equal proportions, a little plagioclase, quartz, occasional biotite, zircon, apatite, rutile, magnetite,

Figure 3. Photograph of a section of the leopardite cut parallel with the direction of the pencils.

and a few small grains of pyrite, with the secondary minerals epidote, chlorite, kaolin, and a green mica.

One of the best exposures of the unakite in its relation to the other granitic rock is along Roaring Fork and a short distance above its entrance into Meadow Fork. The commercial value of the rock would be for decorative or ornamental purposes, but at the present time it has not been developed sufficiently to determine what quantity of this rock can be obtained commercially.

In Chapter III there is a short description of the dikes and veins penetrating the crystalline rocks previously described which include, beginning with the most acid, true quartz veins, pegmatite, aplite and granite dikes of normal composition and texture; and abundant dikes of basic igneous rocks, of which diabase and diorite are the most common types.

Chapter IV treats of the calcareous rocks, limestones and marbles, taking up in detail their varieties, structure, weathering qualities, uses, and geographical distribution. The marble localities are confined to Cherokee, Swain, McDowell, and Mitchell counties. The only ones that have been developed commercially are those in Cherokee county. The marble of Mitchell county is perhaps worthy of more detailed notice on account of its occurrence and quality.

White Marble from Mitchell County:— This marble was first exposed in a railroad cut on the north bank of North Toe River near the mouth of Sink Hole Creek about 3½ miles above Toe Cane Station. The marble is exposed in a bed about 60 feet thick interbedded with typical mica schists, and is exceptionally pure and of very uniform texture. As far as can be judged from the exposure of the blocks that are blasted out, it is remarkably free from joints, It has a beautiful pure white color and takes a good polish. It can be traced northeastward from the outcrop at the railroad for about a mile and is favorably located for quarrying, being on a mountain side about 100 feet above the valley, thus affording natural drainage and space for disposal of waste

material. Considering the location of this marble and its texture, purity, and color, it offers a very favorable commercial quarry proposition.

One peculiar feature of this marble deposit is the occurrence of a large pegmatitic vein in the midst of the marble as illustrated in Fig. 4.

The limestone areas are rather scarce throughout North Carolina and in no place are they of sufficient magnitude to be of any large commercial importance either for building purposes or for burning into lime. In a few localities a small

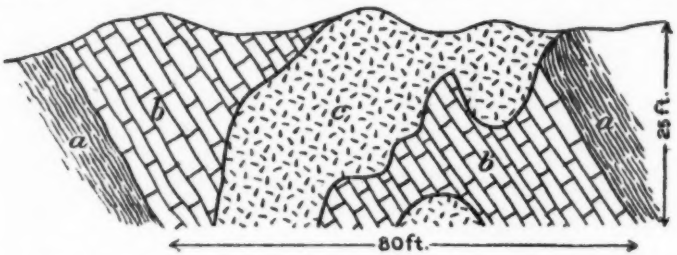

Figure 4. Pegmatic dike (c) cutting the Mitchell county marble (b). The country rock is a contorted typical mica schist (a) which at its contact with the marble is quite calcareous.

amount of the stone is used for road purposes or burned into lime for local use. In Buncombe county, about 2 miles north of Fletcher, two kilns having a capacity of 700 bushels per day have been erected for burning a limestone that is of a peculiarly fine grained structure, containing little or no impurities, the analyses giving 95.32 per cent. calcium carbonate.

The serpentines and verdantique marbles are described in Chapter V. They are at the present time of no commercial importance and they have been described in detail in a previous report of the North Carolina Geological Survey on Corundum and the Peridotites of Western North Carolina.

The sandstones and quartzites, which are taken up in

Chapter VI, are discussed more from a commercial than a scientific standpoint. Although in previous years there has been considerable quarrying of the sandstone from Moore county, in recent years the industry has come nearly to a standstill. This, however, has not been on account of the quality of the sandstone as much as transportation difficulties.

The dikes penetrating the sandstones are taken up in Chapter VII, which contains tables showing their distribution and their relation to the jointing of the sandstone.

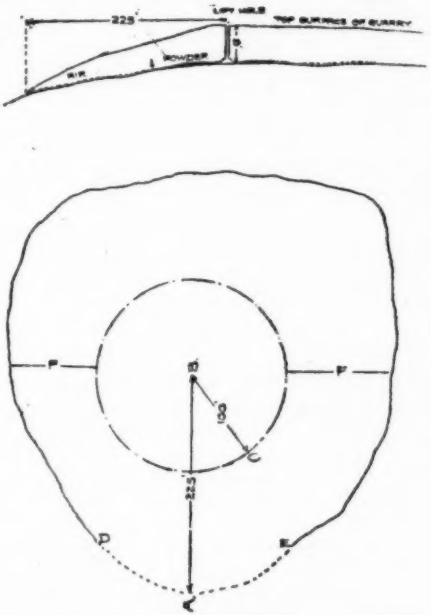

Figure 5. Diagram illustrating method of cleaving granite by means of compressed air. B, lift or drill hole; BO, area cleaved by powder; AFF, area cleaved by compresse air; DE, thin edge on down hill side of quarry where air escaped.

Chapters VIII and IX relate to the quarrying, working and weathering of building stones. One interesting method of quarrying building stones that is especially mentioned is that used by the North Carolina Granite Corporation at its Mt. Airy quarries, which is described as follows:

"In the center of the sheet or area to be lifted a drill hole 2 to 3 inches in diameter is sunk 6 to 8 feet depth, depending on the greatest thickness of stone required, and the operation is continued by the discharging of successive small amounts of powder similarly as described under the method of quarrying by using water* until the crevice extends a distance of 75 feet or more from the hole in all directions. A pipe is then cemented into the hole and connected by means of a globe valve to an air pipe line from an air compresser. Compressed air at 70 to 80 pounds pressure is gradually admitted and the cleavage rapidly extends until it comes out upon the hillside in a thin edge as indicated by the cross-section, Fig 5. A sheet of several acres in extent may be raised in this manner, affording a bed plane approximately horizontal, to which the quarrymen can work, thus securing stone of any required thickness. The first time compressed air was used a pressure of 80 pounds was admitted into the cavity which had previously been extended to a distance of 100 feet from the

*After being drilled, the hole is fired by a succession of light blasts using in the first charge about a handful of blasting powder. The operation is begun by discharging about a quarter of a pound of dynamite in the bottom of the hole. This small charge of dynamite pulverizes the stone slightly at the bottom of the hole and forms a small chamber. The tamping is then cleaned out of the hole which is recharged in the same manner, this time, however, using about a handful of powder. The recharging of the hole is continued with small charges of powder until a small seam has been started at the bottom of the hole extending parallel with the surface. This is found out by using a small steel rod bent at the lower end and sharpened to a point and passing it up and down the hole until the crack is located. After the crack has once been started, the use of light charges of powder is continued, increasing the charges gradually as the seam is found to extend in all directions from the lift hole until the crevice extends a distance of 75 feet or more from the hole.

lift-hole. The power of the air, however, was too great for the easily splitting stone and the cleavage turned abruptly to the surface. In the next hole, however, the compressed air was admitted very gradually and the stone could soon be heard cracking in all directions and in about half an hour the cleavage came to the surface of the hillside as a thin edge some 225 feet from the lift-hole. To extend the cleavage by means of powder for a hundred feet would require from 6 to 12 days, and with water from 3 to 5 hours, while with the compressed air the larger area was split in half an hour.

Appended to the volume is a short description of stone found throughout the State that is suitable for road building, together with a table showing the results of tests made on certain stones suitable for use in road building.

Although this volume deals especially with the economic and commercial phases of the building stones of North Carolina, making it particularly interesting and valuable to contractors, builders, and dealers in building stones; yet there is sufficient detailed scientific work included to make it of considerable interest and value to the student of North Carolina geology.

WHERE THE WIND DOES THE WORK.*

BY COLLIER COBB.

No portion of the North American continent is so widely known, and at the same time so little known, as the chain of low-lying islands and fringing sand-reefs extending along the North Carolina coast for a distance of more than three hundred miles. This is especially true of Hatteras Island, a sand spit whose dangerous projection and shifting shoals have made this portion of our Atlantic seaboard a veritable graveyard of American shipping.

Distinguished scientists on both sides of the Atlantic have discussed the origin of Cape Hatteras without having set foot on the island or coasted along its shores. The origin of well nigh all the features of this coast have been discussed at long range, and yet hardly half a dozen people from the outside world have any personal acquaintance with the island.

It was on this coast that Fessenden and Thiessen experimented successfully with wireless telegraphy. At Kitty Hawk, on these banks, the Wrights conducted their experiments in mechanical flight.

Though difficult of access the inhabitants of these islands are in close touch with the rest of world by the telegraph and telephone lines of the U. S. Weather Bureau and the Life Saving Service as well as by the wireless telegraph.

Those who watch the reports of shipping need not to be told that winds are constant in this region. The strong winds of midwinter come from the north, and the gentler steady

*This article appeared in the *National Geographic Magazine* for June, 1906, with map and nine illustrations in half-tone from photographs, and is here reprinted with the permisson of the editor of that magazine.

winds of midsummer and of the greater part of the year blow usually from a little west of south.

These constant winds were early taken advantage of by the inhabitants, and windmills for grinding corn dot the whole chain of islands, though most of them have now fallen into disuse. A small boy on Church's Island hauls freight for the people of his village on a car furnished with a sail and propelled by the wind.

The frequency of wrecks upon this coast is too well known to require comment; though such is the efficiency of the life savers, who brave the perils of any storm, that life is rarely lost here. But the lightship has sometimes been broken from its moorings on Diamond Shoals and driven upon the Hatteras Banks.

The strong north-winds pile the sands up into great barchanes or medanos, cresentic sand-dunes, known locally as whaleheads, which are steadily moving southward. These are best developed along the Currituck Banks, from Virginia as far south as the Kill Devil Hills, and numbers of them may be seen to the north and to the south of Currituck Light. These whaleheads are composed of singularly homogeneous blown-sands, the horns or cusps pointing to leeward, which is almost due south.

The prevailing winds from a little west of south have rippled the heterogeneous sands on Hatteras just south of the cape, on Shackleford at its southwest extremity, and on the southwest side of Smith's Island. These wind-ripples, started in sands exposed by the removal of a strip of forest next the shore, have grown in size to great sand waves and are advancing on forests, fields, and houses. As the sand-wave has advanced, it has taken up several feet of the loose soil over which it has passed, undermining houses, laying bare the roots of trees, and exposing the bones of the dead in the cemeteries.

Diurnal winds from the sea have piled the sands into small wandering dunes and hillocks, and even sometimes into sand

waves which are marching steadily inward and shoaling the waters of the sound. At Nag's Head, a large hotel constituting a solid obstruction, soon had a sand wave built up a short distance in its rear until the level of the roof was reached, when the wave moved forward and engulfed the hotel. In the immediate neighborhood two cottages suffered a similar fate. Here the land gained on the sound three hundred and fifty feet in ten years.

On the northern end of Hatteras Island a fishing village has been similarly buried, while the sand has entirely crossed the island at several places north of the cape. This movement of the sand was started just after the Civil War by the cutting of trees next the shore for ship timbers, and the section is still known as The Great Woods, though not a stick of timber stands upon it today. Pamlico Sound for two miles from the Hatteras shore is growing steadily shallower from the deposit of blown sand.

On Smith's Island a pilot's village has been buried beneath the sand wave for a number of years, but this has been qnite recently resurrected and its hcuses are again occupied. On Currituck, below Caffey's Inlet Life Saving Station, the sand has advanced entirely across the land, and one man moving his home before the advancing sand has at last built his house on piles in the sound.

The writer has found by experiment that heterogeneous sands, consisting essentially of quartz, orthoclase, some mica, iron, bits of shells, and many mineral substances showing little if any decomposition,* ripple readily in the wind and are easily arrested. This he accomplished in one instance by planting the seed of a native pine and covering the dune with brush. In another case the movement was checked by the unassisted growth of grass upon dunes from which hogs and cattle were fenced out. Several native grasses on these islands are excellent sand-binders; but so far he has found no

*I consider these sands to be of glacial origin, scraped off the granite rocks of New England by the ice-sheet of the last glacial epoch.—O. O.

means of checking the movement of homogeneous sands that do not ripple, these consisting entirely of well rounded and wind-sorted quartz grains of the same size throughout a single dune.

Other trees beside the pine may be used as sand binders. Some live oaks and myrtles serve well in this capacity, and on Hatteras Island young olives and palms have been observed growing on the dunes, though this is the northern limit of both these trees, and they are even unknown on Ocracoke Island next to the south.

As already pointed out, the movement of these sands was in every case started by the deforesting of a strip of land next the shore; but in several instances nature has herself grown forests on dune sands. Above Kitty Hawk Bay large dunes are covered with a growth of pine, maple, oak, cedar, sassafras, locust, elm, beech, persimmon, sycamore, hickory, and in the damp interdune areas cypresses and gums. Here are many veteran pines, some of them having attained a diameter of three feet. An essentially similar forest is found growing upon the high dunes to the southwest of Cape Hatteras, bnt here we have to add the olive to the list, and there are broad interdune palmetto swamps.

On Bogue Banks, where deforesting has only just begun at two points, we have 20 miles of woodland, the virgin forest extending down to the water's edge and preventing the formation of dunes.

From Southport westward into South Carolina the dunes have moved northward and inland in some places completely filling the lagoons. At one point such a filled lagoon has produced a pine forest in something more than forty years.

The checking of these moving dunes presents a problem of increaing importance not only to the inhabitants of these sand keys, but to the navigators of the inland water-ways as well, and it is interesting to know that its solution is at hand, and that the encroachment of the sand may be effectually stopped.

It is fortunate that the strong north winds that pile up the sands and the strong east winds that cause the greater amount of the sand movement blow in the winter months rather than in the season of plant growth. The spring rains are usually of light intensity and long duration, and on Hatteras Island at least they come with the gentler southwest winds. Hence it is comparatively easy to plant grasses and shrubbery in late winter or early spring and have them gain a firm footing and accomplish something of their growth before the strong winds come.

In January, 1886, the writer planted the seed of the loblolly pine on the back of a dune and covered the area with brush cut from a near-by road in process of making. The brush served not only to break the wind but to conserve the moisture of the sands, and today there is a forest of several acres where twenty years ago was a moving sand waste. The method so common abroad of building a barrier dune by means of wind breaks has been tried several times along this coast, but always without success.

The atmospheric humidity of Hatteras Island is greater than that of any other station in the United States except in the Puget Sound region, and even there the excess over Hatteras is not great. Yet there are more days of sunshine on Hatteras than at Cape Henry, or Norfolk, or Wilmington. The heaviest rains come between late July and mid October, after the plants have done most of their growing for the year and when plants in many parts of the country are suffering greatly from the drouth.

The people of these islands are not the slothful bankers and rude wreckers pictured in song and story. They are fair women and brave men, most of whom live and do for others, —lifesavers, heroes. Their homes are comfortable and well kept; they attend regularly upon the services of the church, and their children are in school for eight months of the year, for the inhabitants of Dare County have voted upon themselves a special tax for this purpose. The islanders have

herds of small wild ponies, and flocks of sheep and goats, as well as cattle, on some of the islands.

True some primitive customs are preserved among them, and some early English forms of speech. Their lodges used in fishing and hunting are built after the most primitive types of straw thatch, while a higher type, similar to that used in the village of Gabii in the days of Romulus and Remus, is used as a temporary residence during their camp meetings in the summer, and this higher type of dwelling is on Hatteras built of palmetto thatch.

There is no better type of the average man than the native North Carolina banker.

The possibilities of these islands are as yet undreamed of by their inhabitants and utterly unknown to the outsider, who visits only the most barren of them in the duck-shooting season.

The regaining of the shore strip by reforesting the sands, and the retention of the dunes that are devastating the meadow lands, would make of Hatteras Island, at least, a subtropical garden, where southern fruits and early vegetables once plentiful here might come into the market. The game still lingering among the wooded dunes would be greatly multiplied, and the herds of wild ponies now dwindling away would again increase in numbers. Then conservative lumbering could be added to the industries of the island.

It is also within the range of possibilities that the black beachsands which are concentrated by wave action at a few points might be made to yield from their iron ores a return for the labor of gathering them.

THE CORAL SIDERASTREA RADIANS AND ITS POST-LARVAL DEVELOPMENT.*

H. V. WILSON.

The Coral Siderastrea radians and its Post-larval Development. By J. E. DUERDEN†. Washington, U. S. A. Published by the Carnegie Institution. December, 1904. Pp. 130, with 11 plates.

This handsome Carnegie memoir contains the record of an investigation begun at the Institute of Jamaica and subsequently carried on at the Johns Hopkins University and the American Museum of Natural History in New York. The author's prolonged residence in the West Indies gave him unusual opportunities in the way of command over living material, and the memoir makes valuable additions to our knowledge on many points of coral morphology.

An introduction deals with the systematic zoology and the habits of the species which is abundant and accessible in Kingston harbor. The form is obviously one of those convenient, hardy types destined to play a part in laboratory investigations of histological and physiological character. Both the adult colony and the young polyp after metamorphosis grow in confinement and may be hand-fed. There follows an ample description of the anatomy of the adult. The species, like other West Indian corals, is possibly protogynous, although Professor Duerden calls to mind that Gardiner has established the converse phenomenon, protandry

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†Professor Duerden served as Acting Professor of Biology in this University during the year 1902–'03.

for *Flabellum*. Duerden takes up the question as to the way in which the coral skeleton, as a product of cellular activity, is produced. He confirms Miss Ogilvie's observation that the corallum can be seen in favorable parts of the adult and young polyps to be composed of minute skeletal units of a polygonal shape and exhibiting a fibro-crystalline structure. But whereas Miss Ogilvie interpreted these bodies as actual cells which were produced through the proliferation of the ectoderm, becoming calcified as fast as produced, Duerden regards them as secretory products which are laid down wholly external to the ectodermal cells. In support of this view, essentially that advanced by von Koch, Duerden finds that the layer of ectoderm concerned in the production of the skeleton is always a simple layer, and that, moreover, it is always separated from the corallum by a homogeneous mesoglœa-like stratum. It is in this stratum of homogeneous matrix that the author believes the calcareous crystals forming the skeleton are first deposited.

A third section deals with the post-larval development. The larvæ, of the usual coral type, were obtained in July, and were kept under continuous observation for some months after attachment. Many valuable facts concerning the succession of the tentacles, mesenteries and various parts of the corallum are recorded in this section. A feature of interest lies in the attention paid to individual polyps. The partial transparency of the young animal permits of instructive views during life, and thus in one and the same individual the correlated development of the various organs could be followed from day to day. A result of this method was that periods of rapid growth and relative rest could be distinguished. The author points out that a phylogenetic significance possibly attaches to some of the more persistent stages, such as, for instance, that in which complete pairs of mesenteries (directives) are found at the two ends of the œsophagus, with two pairs, each consisting of a long (complete) mesentery and a short one, on each side of the œsophagus. This condition

continued unchanged for a period varying from three weeks to three months. The author's theoretical views as to the meaning of this particular stage are summed up as follows:

The long retention of freedom of the fifth and sixth pairs of protocnemes suggests to my mind an ancestry in which the mesenteries as a whole, including the metacnemes, were alternately long and short, excluding, of course, the axial directives. Among modern examples this is retained in the mesenterial system of the zoanthids, *Porites*, and *Madrepora*, and was perhaps characteristic of the Rugosa.

The building up of the corallum is followed out in detail throughout the formation of the third cycle of permanent septa. Among the illustrations of this part of the work special mention is due the microphotographs of macerated skeletons of developing polyps, and the figures of living polyps with the beginning skeleton *in situ*. Much interest attaches to Professor Duerden's account of the development of the septa. It has been hitherto assumed that the septa of a new cycle appear in the exocœles (*i. e.*, the space between two pairs of mesenteries), but are later embraced by the newly appearing pairs of mesenteries in such wise as to lie in the entocœles (*i. e.*, the space between the mesenteries of a pair). Thus the same septa would be first exocœlic and then entocœlic. In opposition to this scheme Duerden's observations lead him to the conclusion that while exosepta are formed in successive cycles, they never become entosepta. The cycles of entosepta are strictly new formations, appearing as do the primary six septa in entocœlic spaces. The succession of the cycles of exocœlic septa is maintained through the continued peripheral bifurcation of preexisting exocœlic septa. The bifurcated extremities become the (exocœlic) septa of a new cycle, while the main septa is incorporated in the growing body of one of the last formed cycle of entosepta. Having respect only to the actual facts as observed in *Siderastrea*, it has been found that any one of the permanent septa, later than the first six, has a double origin. It is in part a new formation (entocœlic), and in part a preexisting formation (exocœlic). The

two parts fuse, and the fusion is interpreted by Professor Duerden as the incorporation by a growing organ of the remnant of a vanishing organ. In a developing corallum according to this view exosepta are formed at each stage of growth, only to disappear as the permanent septa, entosepta, come into existence. Thus the development of coral septa affords an excellent example of substitution: temporary organs precede and are replaced by permanent organs performing the same function as the former. As a corollary to this conclusion the author expresses his belief that the exoseptal predecessors of the permanent septa do not wholly disappear in all corals, as independent structures, but persist in some species in the shape of the *pali* found in front of the larger septa.

CHLORAL—α—NAPHTHYLAMINE AND CHLORAL—β—NAPHTHYLAMINE.

ALVIN S. WHEELER AND V. C. DANIELS.

[Chemical Laboratory of the University of North Carolina.]

In an attempt to prepare condensation products of chloral with the two isomeric naphthylamines, we were able to obtain the addition products only. These latter were produced when the reaction was carried out at the ordinary, or better, somewhat reduced, temperature. If the reaction mass was heated to one hundred degrees in order to eliminate the elements of water and thus obtain a condensation product, the reaction went too far and black oily substances resulted. We studied the addition products, however, and found that they were formed by the addition of one molecule of chloral to one molecule of the naphthylamine. This work was done in the spring of 1905 and since the same compounds have recently been described [L. Rügheimer, Ber. d. deutsch Chem. Ges. 39, 1662] we wish to record our results, although we had intended to await further accumulation of material.

CHLORAL—α—NAPHTHYLAMINE, $CCl_3CHOH.NHC_{10}H_7$.

Seven grams of chloral (M. W.=147) were dissolved in 10 cubic centimeters of cold benzene and 5 grams of α—naphthylamine (M. W.=143), dissolved in 15 cubic centimeters of benzene, were added slowly with constant stirring. By surrounding the beaker with cold water the temperature is kept sufficiently low. About 50 cubic centimeters of ligroin are next added, causing a very dense white crystalline precipitate. The yield of the dried product was 7.8 grams, the theoretical being 10.1 grams. The melting point of the crude substance

was 89°C. Purification was effected by dissolving in as small an amount of cold benzene as possible and precipitating with ligroin. Vigorous stirring for about ten minutes is of considerable assistance in causing a complete precipitation. The melting point was raised to 92°C.

The following analytical results were obtained:

I. 0.2265 gram substance was heated with 0.5908 g silver nitrate and fuming nitric acid in a sealed tube. 11 c.c. standard ammonium sulphocyanate solution (1 c.c.=0.0173 g $AgNO_3$) were used in titrating the excess of $AgNO_3$.

II. 0.2117 g substance gave 0.3900 g CO_2.

III. 0.2117 g substance gave 0.0727 g H_2O.

IV. 0.3697 g substance gave 17 c.c. nitrogen at 22°C. and under a pressure of 756 mm.

	Calculated for $C_{12}H_{10}ONCl_3$	Found I.	II.	III.	IV.
Cl	36.61	36.88			
C	49.58		50.24		
H	3.48			3.81	
N	4.83				5.32

Chloral—α—Naphthylamine is soluble in glacial acetic acid, alcohol, and benzene and slightly soluble in ligroin and ether. It is a white crystalline compound, the needle like crystals collecting in bundles like sheaves of grain. It is insoluble in water and turns black when the water is heated. It can not be long exposed to light.

CHLORAL—β—NAPHTHYLAMINE, $CCl_3CHOH.NH.C_{10}H_7$.

Five grams of β—naphthylamine were dissolved in as little ether as possible and to this solution were added 7 grams of choral in 10 c.c. of ether. After concentrating the solution to about 20 c.c., ligroin was added in considerable quantity. A dense white precipitate of the addition product was immediately thrown down. On account of the difficult solubility of β—naphthylamine in ether, too much of it was used in our first work and the isolation of the product after the addition

of ligroin was troublesome. Rügheimer uses chloroform in place of ether in this preparation. The yield of pure substance was rather small, about 27 per cent of the theoretical.

The following analytical results were obtained:

I. 0.2289 *g* substance was heated with 0.6148 *g* silver nitrate. 1.53 c.c. of standard ammonium sulphocyanate solution (see) above) were used to titrate the excess of silver nitrate.

II. 0.2862 *g* substance gave 0.2332 *g* CO_2.

III. 0.2862 g substance gave 0.0961 g H_2O.

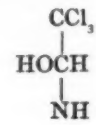
IV. 0.2912 g substance gave 12.2 c.c. nitrogen at 18°C and under a pressure of 758 mm.

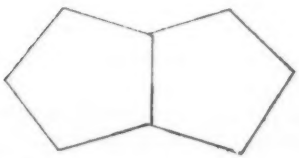
	Calculated for $C_{12}H_{10}ONCl_3$	Found I.	II.	II.	IV.
Cl	36.61	36.98			
C	49.58		50.08		
H	3.48			3.52	
N	4.83				4.82

The *β*—isomer crystallizes in colorless needles and in the mass is light and bulky. It is solnble in ether, benzene, and alcohol but only slightly soluble in ligroin. It melts at 104°C and soon decomposes on exposure to the light.

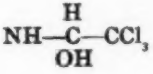
The constitution of these addition products is represented by the following graphic formulae:

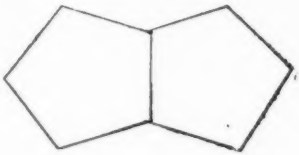
Chloral—α—naphthylamine,





Chloral—β—naphthylamine,





Chapel Hill, N. C.,
Sept. 24, 1906.